

A Study of Equity in Mathematics Education:
Lessons from Japan for U.S. Teacher Preparation

Author Note

Dr. Linda H.L. Furuto, formerly at the Department of Mathematics, University of Hawai‘i – West O‘ahu, is now at the College of Education, University of Hawai‘i at Mānoa.

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Correspondence concerning this article should be addressed to

Dr. Linda H.L. Furuto, College of Education, University of Hawai‘i at Mānoa, 1776 University Avenue, Everly Hall 224, Honolulu, HI 96822. Contact: lindafuruto@post.harvard.edu

Abstract

This study comes at an opportune moment for Japanese and U.S. educators, policymakers, and researchers given the trends of global policy and equity-based reform. Discussions of academic achievement in both societies allow us to examine accessibility in mathematics education in order to best prepare teachers to serve the needs of students. Quantitative and qualitative analyses were employed to answer the underlying research question, how does privatization affect equity in mathematics achievement as observed in upper-level Japanese elementary schools? The students and sites were selected because of the turning point in educational paradigms that occurs during the schooling of preadolescents, including shifts in the types of instruction received and academic performance expectations. The contextual background then leads to a discussion on implications for teacher preparation programs in the U.S., where a culture of privatized education has emerged of academic tutoring and test preparation. The increasing public and private sector disparities serve as an urgent call to address issues of equity in both nations.

Keywords: equity, access, diversity, mathematics achievement, supplemental education.

A Study of Equity and Access in Mathematics Education:

Lessons from Japan for U.S. Teacher Preparation

This study comes at an opportune moment for Japanese and U.S. educators, policymakers, and researchers given the trends of global policy and equity-based reform. Discussions of academic achievement in both societies allow us to examine mathematics education in order to best prepare teachers to serve the needs of students (MEXT, 2014; PISA, 2012). Research was conducted at four public and private schools to answer the question, how does privatization affect equity in mathematics achievement as observed in upper-level Japanese elementary schools? In upper-elementary school, students experience dramatic shifts in the type of instruction received, become aware of expectations adults have for them, and undergo psychological and physiological changes. The complexity of educational concerns at this juncture makes change difficult, and the experiences of Japanese students provide valuable information. Quantitative and qualitative data analysis provides insight into the roles of public and private sectors on the Japanese education system. Finally, the contextualized background leads to further discussion on implications for U.S. teacher preparation programs.

Equity and Accessibility

At the surface, it appears that Japan provides a K-12 system of education open to all citizens (Hanushek & Luque, 2003; Tyack, 1974). However, there is a growing tendency for the wealthy to opt for private schools and supplemental education that provide children greater opportunity to pass national examinations and eventually entrance to one of the prestigious universities. The Japanese system primarily bases the selection process into higher level education on a single test score, rather than measuring the abilities of students on a range of endeavors (i.e., essays, extra-curricular activities). *Juku* (cram school) and supplemental

education in Japan supply not only educational choice but a form of competition to the public school system as well (Horio, 1994; Stigler & Hiebert, 1999).

According to recent government surveys by the Japan Ministry of Education, Culture, Sports, Science, and Technology (MEXT), the largest *juku* companies are traded on stock exchanges. It is estimated that more than 70% of students in Tōkyō attend *juku* which has become an important consumer commodity (MEXT, 2011; MEXT, 2014). The growing acceptance of market-driven approaches in privatized education continues to strengthen this trend as evidenced in studies by Nicholas and Berliner (2007) and Rosenbaum and Kariya (1989).

Similar trends have emerged in the U.S., where the National Assessment for Educational Progress (2012) advocates for further research to prepare the next generation of scholars for economic growth and development. This is critical because “ensuring America’s stature as the world’s leader hinges on our ability to educate all students in a climate of educational equity as we move into an era with increased technical and global demands” (p. 2). Even though the U.S. is working to develop higher standards for what students should be learning, along with the means for assessing their progress, the solutions implemented thus far have not had a noticeable impact (NAEP, 2013; PISA, 2012). In light of the situation, the U.S. has developed an emergent culture of relying on privatized education. A booming industry offers online diagnostic tests, private academic tutoring, SAT prep courses, and personalized guidance on how to navigate the college-application process. A review of the literature, including Beauchamp (2003) and Kobayashi (2009) shows that the number of studies and the findings on privatized education in the U.S. remains limited which strengthens the importance and value of this study.

Overview of Privatization in Japan

There is a wide-range of academic institutions outside of the public school system in Japan, including home tutors, correspondence courses, *juku* (cram schools), and *yobiko* (examination preparation schools), among others. These forms of extra schooling have been described as “shadow education” because their private sector curriculum tends to shadow and enhance the curriculum offered in the public schools (Rohlen, 1983; Stevenson, Azuma, & Hakuta, 1986).

In a survey of over 60,000 students conducted by the Ministry of Education, Culture, Sports, Science, and Technology (MEXT, 2011), the percentage of students attending *juku* was documented over a twenty year period. Students said one of the most important benefits of attending *juku* was that they could “go beyond public school lessons” (p. 7). If students can surpass the standards, classroom study becomes a place of academic review. Academic *juku* have the opportunity to provide lessons not offered by public schools. For example, some parents enroll their elementary school age children to study English, which doesn’t become compulsory in public schools until later years. When *juku* accelerates students to the extent that school becomes a place for review, *juku* begins to impede on public education, and the state system is no longer a place of educational equity (DeCoker, 2002; LeTendre, Baker, Akiba, Goesling, & Wiseman, 2001). Enrollment also varied markedly according to the size and location of cities, with a much higher participation rate of students in large, metropolitan areas such as Tōkyō (MEXT, 2011).

Privatization of educational services continues to be in demand as long as entrance examinations are key to future career success and *juku* can help students improve their scores. In a study on financing Japanese education, Nomi (2013) shows that socioeconomic background is an indicator of academic achievement. Moreover, the growing presence of private educational

services in Japan has been a trend in Japan since the mid-1990s. The most sought after schools combine the junior high and high school years into a continuous six year program, enabling students to attend the same school uninterrupted by an entrance exam that normally is taken at the end of Japanese junior high school. Such private schools claim that, in the absence of the test, they are freer to offer augmented curricular and cultural activities and respond more sensitively to individual needs. Such schools also have a track record of placing their graduates in competitive universities.

LeTendre, Hofer, and Shimizu (2003) demonstrate that the composition of students who gain admission to the most selective university in Japan has changed dramatically over the course of 25 years from predominantly public school graduates to predominantly private school students. They cite the following statistics, “Of the top 20 high schools in the country that sent students to the nation’s most prestigious University of Tōkyō in 1964, five were private schools. By 1979, the private school figure had grown to 11, and by 1989, 25 years later, 75% of the schools sending graduates to the University of Tōkyō were private and only five were public” (pp. 279-280). If one accepts the premise that attending a test-focused *juku* is a requirement for successful admission to a private high school or selective university, then it seems clear that studying at *juku* is an integral component of educational success in Japan (Amano, 1996). The next section on methodology describes the research undertaken to draw connections between equity and lessons from Japan for U.S. teacher preparation programs.

Methodology

Research was conducted at three public elementary schools and one private *juku* (cram school), with permission to use data granted by their respective schools and districts. The upper-elementary students and schools were selected because of the turning point in educational

paradigms that occurs during the schooling of preadolescents (10-12 year olds). The tensions and conflicts around early youth development mirror wider conflicts in Japanese society (e.g., between the ideal of learning as an exploration and learning as examination preparation), and the experiences of Japanese students provide valuable information. The sample population included all 278 fifth and sixth graders in the four schools, and there was no missing data. Techniques were utilized to control for errors in data analysis including, but not limited, to the following: coverage, sampling, non-response, and measurement. These were adapted from Schilling and Neubauer's (2009) study on acceptance sampling in quality control, and Owen and Zhou's (2000) work on safe and effective importance sampling. Table 1 provides a description of major variables and measurements.

Survey analysis was the main methodological strategy employed to answer the underlying research question, how does privatization affect equity in mathematics achievement as observed in upper-level Japanese elementary schools? The quantitative survey was based on the work of Astin and Astin (2000) and Bok (1996). The survey included demographic, attitudinal, family/community-related, and future-oriented objective questions. Data analysis of ordered logistic regression focused on the logit and probit versions of the ordered regression model, in terms of an underlying latent variable, selected to fit the types of data and variables under consideration.

Table 2 is a contingency table of grade level by school. The chi-square test is not statistically significant, indicating there is no association between grade level and school attended. There is a fairly even representation of fifth and sixth graders across all four schools. Overall, 52.52% of the population is in the fifth grade (146 students) and 47.48% is in the sixth grade (132 students). 24.82% of the sample is from public school 1 (69 students), 30.58% is

from public school 2 (85 students), 28.42% is from public school 3 (79 students), and 16.19% is from private school 4 (45 students).

Features of Japanese schooling were investigated secondarily with qualitative methodological strategies. The focus groups were semi-structured, open-ended interviews, involving 4-5 participants. They were complementary to quantitative methods, providing further understanding of the organizational structure of schools, curriculum and instruction, assessment and evaluation, and their influences on mathematics achievement. Focus group questions were based on the work of Bickman, Hedrick, and Rog (1993) and Boyatzis (1998), and included, What is the role of the public and private school teacher in the lives of students?; What types of instructional pedagogies are utilized?; and How is academic achievement measured in public and private schools? Focus group interviews were conducted with 25 fifth and sixth grade students and 25 teachers/administrators at the four research sites, for a total of five student focus groups and five teacher/administrator focus groups.

Major Findings

Descriptive analyses illustrate general characteristics of the sample population of the 278 fifth and sixth grade students at four public and private schools. Contingency tables of gender by school and age by school indicate that gender and age composition are relatively homogeneous across schools. Approximately half of the population sample is male (48.56%, 135 students), and the other half is female (51.44%, 143 students). Interestingly, there is a noticeable difference between male and female numbers at private school 4, where 57.78% of the students are male and 42.22% are female. The majority of students are 11-12 years of age (97.84%), with a few 10 and 13 year olds. The ages are generally evenly spread across school. There tend to be slightly more 11 year olds (53.60%, 149 students) than 12 year olds (44.24%, 123 students).

The intraclass correlation of mathematics achievement by school also provides useful information. The intraclass correlation (0.55762) is substantial and shows that schools are significantly different across populations and fairly homogeneous within, as expected. Table 3 provides a contingency table of cross-tabulation and chi-square of mathematics achievement by school that support intraclass correlation findings. The chi-square test is statistically significant at the 0.001 α -level ($p = 0.000$), indicating there is a strong association between mathematics achievement and school attended.

Quantitative Analysis

The trends of students attending *juku* by school are revealing about the types of students that have access to supplemental education. Table 4 is a cross-tabulation and chi-square of the number of years attended *juku* by school. In each cell within the table, the top number is the frequency, the second number is the row percentage, and the third number is the column percentage. The Pearson chi-square value is given at the bottom, along with the significance probability. The chi-square test is significant at the $p < 0.001$ level, indicating that there is a relationship between schools and the number of years students attend *juku*.

The number of years attended *juku* is divided into three categories (0-1 years, 2-5 years, and 6-7 years). Attending *juku* for 2-5 years at the elementary school level is a good indicator of time, resources, and financial investment of parents in their children. Most of the students in this category began attending *juku* when they were in the first or second grade. 26.15% of students at public school 1, 21.18% of students at public school 2, 13.92% of students at public school 3, and 42.22% of students at private school 4 attended *juku* 2-5 years.

In Tables 5 and 6, mathematics achievement is the outcome variable and number of years attended *juku* is the predictor variable. An ordered logistic regression of *juku* attendance and

mathematics achievement is shown in Table 5. Mathematics achievement has three categories from 1 (low) – 3 (high), and is based on the elementary school mathematics grades of the student measured in the quantitative survey. The number of years attended *juku* proves a statistically significant predictor of mathematics achievement at the 0.05 α -level ($p = 0.049$). A one unit change in the number of years attended *juku* is associated with a 0.94 increase in the logistical odds of being in a higher category of mathematics achievement. Thus, a one unit change in number of years attended *juku* results in a significant difference on the outcome of mathematics achievement.

The odds ratio provides information to determine the effect of mathematics instruction on mathematics achievement. A student's ability to move to the next higher category of mathematics achievement is 2.558, with a one point increase in number of years attended *juku*. Recall, mathematics achievement is a three point system, so a more than two point increase is a critical finding.

Ordered logistic regression may be expressed as a probability, and Table 6 provides predicted probabilities of mathematics achievement given the number of years attended *juku*. The predicted probability of a student with 0-1 years of *juku* having a low level of mathematics achievement is 0.1906, while a student with 6-7 years of *juku* having a low level of mathematics achievement is much less at 0.0347. On the opposite end of the spectrum, the predicted probability of a student with 0-1 years of *juku* having a high level of mathematics achievement is 0.3537, while a student with 6-7 years of *juku* having a high level of mathematics achievement is more than double that amount at 0.7817. Overall tests of the parallel regression/proportional odds and other assumptions were met.

The analysis confirms that educational equity in Japan is affected by the ability of the middle- and upper-classes to pay for the extra schooling in private *juku* that less wealthy parents are unable to provide. A noteworthy finding of the study through ordered logistic regression was that each additional year of *juku* amounted to an increase in mathematics achievement in terms of predicted probabilities and tests of statistical significance. *Juku* have become such an indispensable part of a student's college preparation that those who can afford it attend. The most successful *juku* (measured by the number who pass the elite universities' exams) have become so profitable that they are able to hire the best teachers and use the newest technology to evaluate and monitor performance (Nichinōken, 2008b).

Qualitative Analysis

Qualitative analyses were also performed at the four school sites through focus groups with semi-structured, open-ended interviews, involving 4-5 participants. These were complementary to quantitative methods, providing further understanding of the organizational structure of schools, curriculum and instruction, assessment and evaluation, and their influences on mathematics achievement (Fetterman, 1998; Rog & Bickman, 1998).

One of the illuminating questions included, "What is the role of the public and private school teacher in the lives of students?" At public school 1, a focus group of educators provided insight into this question. One teacher commented, "From 2013, curriculum content for public schools has been revamped and increased, necessitating longer school days and, inevitably, a move back to Saturday schooling in many areas of Japan." Another teacher from a focus group at public school 3 added, "*Juku* education provides a way for students to get ahead and find a bridge from regular schooling to the next level up, whether it's middle school, high school, or

university.” These teachers recognized the paths students take toward lifelong goals and the importance of the private and supplemental industry.

Another informative focus group question was, “What types of instructional pedagogies are utilized?” At public school 2, a group of fifth and sixth grade students provided comments such as, “It’s different at regular school and *juku*. When I’m here [public school 2], I mostly listen to the teacher and copy down notes....but when I’m at *juku*, my teacher tells us this is not ‘drill and kill’, open your mind!” To which a student in the same focus group added, “I don’t go to *juku*, so I don’t know what that’s like. Here I read from the textbook and listen carefully to my teacher, and sometimes we do group work. But there are a lot of students in the class, so I don’t really feel comfortable talking too much.” From these and other comments, curriculum, instruction, and access to resources were coded as key factors leading to learning and growth.

Now we will turn our attention to an in-depth look at Nichinōken *Juku* Cram School, which is among the most prestigious and reputable cram schools in Japan. As one of the largest providers of supplemental education in the country, research at Nichinōken *Juku* has much to offer in terms of understanding the intersections of private and public education in Japan. Each year, Nichinōken *Juku* provides 33.5% of the students to the top ten private junior high schools in the Tōkyō area (Nichinōken, 2008a). This is the highest and most distinguished figure in the country. Most students attend public elementary schools, but their parents send them to private junior high schools, high schools, and universities.

Nichinōken *Juku* content mainly focuses on mathematics, social studies, science, and *kokugo* (Japanese national language). According to Principal Asai, Nichinōken *Juku*’s educational strategies aim to fulfill the mission of “meeting the needs of students through complementary education to their six years of elementary schooling” (Asai, M., personal

communication, August 12, 2013). Today, Nichinōken *Juku* realizes there is still a strong focus on examination preparation; however, in light of global pressures to make education accessible to all there is a growing emphasis on quality (Kobayashi, 2009; MacLeod, 2009; Nomi, 2013).

In *juku* and supplementary institutions, teachers and staff strive to promote the character of students in relation to the greater society through structural and pedagogical strategies. There were three main themes that emerged from qualitative focus group interviews and participant observations, including: mathematics resources, monitoring progress and expectations, and curriculum design. These developments in Japan have implications for the U.S. education, and will be explored in the next section.

Implications for U.S. Teacher Preparation

Based on research data, there are three main implications for U.S. teacher preparation in the areas of: (1) mathematics resources, (2) monitoring progress and expectations, and (3) curriculum design. These will be discussed within the framework of major longitudinal, international studies such as the Trends in International Mathematics Science Study (TIMSS) and Programme for International Student Assessment (PISA). Data from TIMSS and PISA reveal parallel themes extracted from quantitative and qualitative research data in this study.

The Trends in International Mathematics Science Study (TIMSS) resulted from the need for reliable and timely data on the mathematics and science achievement of U.S. students compared to that of students in other countries two decades ago. TIMSS is the most comprehensive and rigorous assessment of its kind undertaken, and in 2011 there was a total of 63 participating countries. Director of TIMSS video studies, James Stigler, concluded that more studies are needed around early youth development that mirror wider societal issues (Cozzens & Fuhrman, 2001; Stigler & Hiebert, 1988). Moreover, National Center for Education Statistics

studies based on TIMSS results assert that “instructional practices and expectations of all children regardless of cognitive factors is one of the leading variables in increasing academic achievement” (2003, p. 2).

The Programme for International Student Assessment (PISA) is a triennial international assessment that measures 15-year-old students’ reading, mathematics, and science literacy. It is the product of collaboration between participating countries and economies through the Organisation for Economic Cooperation and Development (OECD). To date, students representing more than 70 countries and economies have participated in the assessment. According to 2012 PISA data, Japan is ranked 9th in the world with an overall mathematics score of 529, while the U.S. is ranked 31st with an overall mathematics score of 487 which is below the average PISA mathematics score of 496 (PISA, 2012). PISA tests are uniquely designed to assess to what extent students can apply their knowledge to real-life situations at the end of compulsory education. Specifically, 2012 PISA assessment found that “among data on student, community, and institutional factors that could help explain differences in mathematics performance... access to equitable and quality mathematics resources is key to attaining academic success” (PISA, 2012, pp. 3-4).

Mathematics Resources

As revealed in the aforementioned international studies, mathematics resources are an important factor in academic achievement and teacher preparation, particularly mathematics textbooks. U.S. mathematics textbooks are extremely long—often 700-1,000 pages (Baker, 2001; Stigler & Hiebert, 1999). Excessive textbook length often detract from applications such as those present in Japanese supplementary education, and can contribute to a lack of coherence. Mathematics textbooks are much smaller in many nations such as Japan with higher mathematics

achievement than the U.S., thus demonstrating that the great length of our textbooks is not necessary for high achievement. Representatives of several publishing companies who testified in the National Council of Teachers of Mathematics Address “Foundations for Success” indicated that one substantial contributor to the length of the books was the demand of meeting varying state standards for what should be taught in each grade. It is recommended that publishers make every effort to produce shorter and more focused mathematics textbooks.

Access to resources is an arena where the public and private sector disparities are exposed. Because of their private nature, Japanese supplemental education programs can delve further into subject matter. Unlike public schools, they can be non-ideological about controversial topics such as preparing for high-stakes exams, for example, and teaching to the test. The following is an example taken from *Nichinōken Juku*, which provides textbooks, specialized libraries, facilities, and other materials that are absent at public elementary schools many of the children attend. These resources give students space to link the lessons to previous knowledge, control what parts of learning to use, and develop the skills to explain concepts intuitively.

In the field of mathematics, students have the opportunity to pursue the study of logic and critical thinking in an environment that fosters brainstorming, probing arguments, and actively analyzing solutions. For example, in a fifth-grade mathematics class, one of the topics included calculating rate based on distance and time. Mr. Asano opened the class with, “Tell me what you know about rate and connect this to real-world applications” (Asano, T., personal communication, January 27, 2014). The first 70 minute period solely focused on exploring the formula, $\text{rate} = \text{distance} \div \text{time}$. This solidified the foundation for proceeding to the average speed of objects during the second 70 minute period of mathematics. Students began by

selecting seven moving objects of their choice and ranking them from slowest to fastest. Then, the students were allowed to use resources within Nichinōken *Juku*—computers, books, notes, compasses, rulers, protractors, teachers/staff, internet, and other mathematical tools—to calculate the speed. A couple of groups creatively chose animals (snail, sloth, dog, grasshopper, horse, rabbit, cheetah), and transportation modes (cow, horse, car, boat, bullet train, airplane, space shuttle). To measure speed, the first group combined innovative resources with mathematical reasoning. They used a regular polygon shape to represent a snail, and moved it slowly along a ruler to simulate measurement of speed and distance. One member of the group timed the movement on a stopwatch and another estimated distance based on the Cartesian coordinate system. They critically and insightfully examined the data, assumptions, and conclusions.

This engaging and thought-provoking experiment conducted by students under the supervision of their teachers, along with engaging Japanese textbook content, provides examples for development and use of mathematics resources in the U.S. Students should be encouraged to develop a deeper comprehension of the elementary concepts in their own words and frameworks. As they explore real-world applications, the knowledge gained leads to ownership of quality, enduring learning.

Monitoring Progress and Expectations

The Japanese supplementary education industry utilizes various methods of observations and behavioral-testing and monitor student progress performed by teachers and supervisors (Komiya, 2007; Nicholas & Berliner, 2007). Special meetings are scheduled to discuss the character, problem-solving style, attitude toward learning, and individual behavior. After combining this assessment with the performance on the four core subjects (mathematics, social studies, science, and Japanese national language), Japanese teachers determine how to best help

students. The strength of this relationship transfers into personalized support and tailored expectations. On a personal level, teachers know where students live, their family backgrounds, academic challenges, and future goals. For example, a map in the main room at Nichinōken *Juku* pinpoints to where each student's home is located in the vicinity. Parents trust the teachers and staff because their children are given such close, supervised attention.

The impact of family expectations and influence on student performance should not be underestimated. Almost immediately after birth, Nichinōken *Juku* parents generally take a strong, vested interest in the academic development of their children. According to General Manager Ōta Katsumi, "Mothers often spend hours on academic games and other activities supportive of learning" (Ōta, K., personal communication, April 20, 2014). It is common for parents to buy books for preschoolers, including those written in English to cultivate language skills at an early age. Most children enrolled in *juku* and supplementary education know how to read and write before they enter elementary school, and can do simple computations, which supports the need for better quality early childhood education as an area for further research.

Once a child enters elementary school, the maternal involvement increases significantly as evidenced by quantitative and qualitative data collection in this study. There are classes for mothers called *mama juku* that prepare the mothers in subjects their children are studying (Hess, Holloway, & McDevitt, 1986; White, 1987). Collaborative homework is considered a means for developing a sense of responsibility in the child and for molding character. This type of constant parental expectation for improved performance is present throughout a child's schooling years up until university, and it is intensified by students in the private, supplemental education system.

This has implications when contrasted with Western theories of achievement, which tend to emphasize individual effort and ability. The Japanese consider academic achievement to be

an outgrowth of a cooperative effort and planning. In other words, if students work hard and stay on task, they can learn. Teachers and parents at Nichinōken *Juku* consistently uphold the belief that “individual effort is of greater significance than individual ability when based on inclusion of family and community values and expectations” (Asai, M., personal communication, August 12, 2013). The U.S. National Mathematics Advisory Panel Report (2008), supported by the National Council of Teachers of Mathematics, advocates the finding that increased collaborative instruction and learning leads to increased achievement. This includes not only classroom learning, but the involvement of parents, teachers, and the community.

Curriculum Design

Finally, curriculum design is another area where lessons learned from Japan may impact U.S. teacher preparation programs. The Japanese public sector, following a uniform, centralized curriculum, allows for the outward appearance of equity, while the private sector, in its parallel curriculum of supplemental study, allows for the reality of a competitive world where students strive to get ahead. Since there is no direct connection between the private sector and the Ministry of Education, Culture, Sports, Science, and Technology (MEXT), the curriculum, textbooks, and lessons designed and created by *juku* and supplementary education institutions are generally based on entrance examinations into prestigious junior high and high schools. Curriculum is designed to push students to excel, rather than catering to the lower-achieving students. *Juku* classes are often one semester to one year ahead of their public elementary school peers. For example, the fifth graders in one private school 4 class were studying the same materials on division and multiplication of fractions as their sixth grade peers at a nearby public elementary school. *Juku* and most privatized systems in Japan utilize weekly and monthly tests that result in the shifting of ability groups. The achievement tests assess proficiency and

knowledge content of national entrance examinations, in addition to *juku* and supplementary education curriculum.

The rising attendance at the Japan's most prestigious universities by students from wealthier families undermines the egalitarian thrust of the educational system, and gives us reason to examine the U.S. case more closely (Beauchamp, 1991, 2003; Rosenbaum & Kariya, 1989). The result is that parents bridge the gaps of public schooling through the private purchase of supplemental education lessons. To test well is critical for Japanese students, as universities in Japan almost exclusively base their admissions decisions on test scores (Nomi, 2013; Okano & Tsuchiya, 1999). Privatization has created a system for the purpose of passing entrance examinations in Japan, and is forging a growing market in the U.S.

The U.S. phenomenon follows this example in some respects. As in Japan, private tutoring has taken off due to the competitive pressures of high-stakes examinations. The two leading test-preparation firms in the U.S., Princeton Review and Kaplan Test Prep, profit from the weight given to SAT scores in college admissions offices. U.S. parents see higher education as key to the future economic success for their children, and tutoring services benefit from the inability of public schools to address a controversial issue such as test preparation with the single-mindedness of a for-profit business.

In the private-tutoring phenomenon in the U.S., firms sell enrichment, remedial, and test-preparatory services. They strengthen their product lineup with services that meet the needs of a capitalistic market. For example, Princeton Review, Kaplan, and other test preparation companies offer secondary schools and college guidance packages. These take advantage of parental anxiety and the inability of over-burdened high school counselors to provide close assistance in a process that is growing more competitive and strategic. Mastering the curriculum

taught very often determines a student's future employment and lifestyle (Aso & Amano, 1983; Cummings, Beauchamp, Ichikawa, Kobayashi, & Ushiogi, 1986).

Raising the level of mathematics achievement through mathematics resources, teacher/parent expectations, and curriculum design are three lessons for U.S. education. There is much we can learn from trends in the Japanese educational system. In Japan, *juku* and the form of specific, packaged education they provide are so essential to preparatory education that some educators have proposed ending public support of education at the elementary and secondary levels, allowing the *juku*-type education to replace public schools (Cummings, 1980; Horio, 1994; Okano & Tsuchiya, 1999). While this is not expected to occur in the U.S., the benefits of supplemental education based on the three areas of implications are documented this study and supported by findings from major longitudinal, international studies such as the Trends in International Mathematics Science Study (TIMSS) and Programme for International Student Assessment (PISA).

Further Discussion

This article began with the major role supplemental education plays in ensuring the success of Japanese students, both on tests administered within the country and international comparisons made on the basis of mathematics achievement test scores. The growing pressure to succeed on examinations is taking a toll in Japan, with educators questioning its impact, both on growing disparities between the wealthy and poor and the fact that tests are starting to determine curriculum. Concurrent research as a visiting scholar at the University of Tōkyō and maintaining connections with the school sites provided complementary macroperspective analysis with hands-on learning within the classroom environment.

Quantitative and qualitative data collected at four public and private schools in Japan showed the degree to which the private sector is influential in shaping Japanese education. Understanding how upper-level elementary school students (10-12 years old) balance culture, peers, academics, and other processes offered a valuable opportunity to examine their impact on educational achievement. The trends of students attending *juku* by school were revealing about the types of students with access to supplemental education. Ordered logistic regression showed that there was a statistically significant relationship between mathematics achievement and the number of years students attended *juku* at the 0.05 α -level ($p = 0.049$). The analysis highlighted the effect of socioeconomic class and the ability to pay for the extra schooling in the private sector on mathematics achievement. Private U.S. companies see a potential market in the nation's public school systems whose students perform poorly on standardized tests. Such tests are increasingly administered to monitor U.S. student performance, particularly in the fields of mathematics and science (Hida, 2009; Kobayashi, 2009; NCES, 2003).

This study sharpened questions about equality and accessibility through relationships in public and private education. The implications for mathematics resources, monitoring progress and expectations, and curriculum design are critical to meet the needs of students as the gap grows increasingly larger between sectors, and are areas for continued research. The Japan Ministry of Education, Culture, Sports, Science, and Technology (MEXT) and U.S. Department of Education recognize the great pressure being placed on students to succeed through privatized education, and it is hoped that we continue to work together to ensure education is provided for the good of our students (NAEP, 2013; MEXT, 2014).

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Table 1

Description of major variables and measurements

Variable Name	Description	Measurement
q00	School	1 = Public School 1 2 = Public School 2 3 = Public School 3 4 = Private School 4
q01	Grade Level	1 = Fifth Grade 2 = Sixth Grade 3 = Other
q02	Gender	1 = Male 2 = Female
q03	Age	1 = < 9 Years 2 = 9 Years 3 = 10 Years 4 = 11 Years 5 = 12 Years 6 = > 12 Years
q04	Anticipated Highest Academic Degree	1 = Junior College 2 = University 3 = Graduate/Professional School 4 = Other
q05	School-related Experiences	1 = Frequently 2 = Occasionally 3 = Never
q06	Future Occupation	1-18 = Various Occupations 19 = Other 20 = Haven't Decided
q07	Hours Spent Doing Weekly Activities	1 = None 2 = 1-2 Hours 3 = 3-5 Hours 4 = 6-10 Hours 5 = 11-15 Hours 6 = 16-20 Hours 7 = 20+ Hours
q08	Personal Importance of Values/Goals	1 = Essential 2 = Somewhat Important 3 = Not Important
q09	Items Possessed by Respondent	1-12 = Various Items
q10	Rating of Respondent's	1 = Upper 10%

	Characteristics/Traits	2 = Above Average 3 = Average 4 = Below Average 5 = Lower 10%
q11	Elementary School Mathematics Grades	1 = High 2 = Upper Middle 3 = Middle 4 = Lower Middle 5 = Lower 6 = Don't Know, Can't Remember
q12	Teacher Expectations and Views	1 = Frequently 2 = Occasionally 3 = Never
q13	Number of Years Attending <i>Juku</i>	1 = < 1 Year 2 = 1 Year 3 = 2-3 Years 4 = 4-5 Years 5 = 6-7 Years 6 = > 7 Years
q14	Grade Level Began Attending <i>Juku</i>	1 = First Grade 2 = Second Grade 3 = Third Grade 4 = Fourth Grade 5 = Fifth Grade 6 = Sixth Grade

Table 2

Contingency table of grade level by school

grade level	school				Total
	1	2	3	4	
grade 5	38	42	42	24	146
	55.07	49.41	53.16	53.33	52.52
grade 6	31	43	37	21	132
	44.93	50.59	46.84	46.67	47.48
Total	69	85	79	45	278
	100.00	100.00	100.00	100.00	100.00

Pearson $\chi^2(3) = 0.5347$ Pr = 0.911

Note: Table 2 is a contingency table of grade level by school. The chi-square test is not statistically significant, indicating there is no association between grade level and school attended. There is a fairly even representation of fifth and sixth graders across all four schools in the study.

Table 3

Contingency table of mathematics achievement by school

acadachvt	school				Total
	1	2	3	4	
1	3	3	35	0	41
	4.62	3.90	52.24	0.00	16.27
2	19	55	29	3	106
	29.23	71.43	43.28	6.98	42.06
3	43	19	3	40	105
	66.15	24.68	4.48	93.02	41.67
Total	65	77	67	43	252
	100.00	100.00	100.00	100.00	100.00

Pearson $\chi^2(6) = 168.0325$ Pr = 0.000

Note: Table 3 provides a contingency table of cross-tabulation and chi-square of mathematics achievement by school that support intraclass correlation findings. The chi-square test is statistically significant at the 0.001 α -level ($p = 0.000$), indicating there is a strong association between mathematics achievement and school attended.

Table 4

Cross-tabulation and chi-square of juku attendance by school

years <i>juku</i>	school				Total
	1	2	3	4	
0-1 yrs	51 24.88 73.91	66 32.20 77.65	68 33.17 86.08	20 9.76 44.44	205 100.00 73.74
2-5 yrs	17 26.15 24.64	18 27.69 21.18	11 16.92 13.92	19 29.23 42.22	65 100.00 23.38
6-7 yrs	1 12.50 1.45	1 12.50 1.18	0 0.00 0.00	6 75.00 13.33	8 100.00 2.88
Total	69 24.82 100.00	85 30.58 100.00	79 28.42 100.00	45 16.19 100.00	278 100.00 100.00

Pearson $\chi^2(6) = 37.8335$ Pr = 0.000

Note: Table 4 is a cross-tabulation and chi-square of the number of years attended *juku* by school. In each cell within the table, the top number is the frequency, the second number is the row percentage, and the third number is the column percentage. The Pearson chi-square value is given at the bottom, along with the significance probability. The chi-square test is significant at the $p < 0.001$ level, indicating that there is a relationship between schools and the number of years students attend *juku*.

Table 5

Ordered logistic regression of juku attendance and mathematics achievement

Ordered logistic regression	Number of obs	=	252
	Wald chi2(1)	=	3.87
	Prob > chi2	=	0.0490
Log pseudolikelihood = -250.81947	Pseudo R2	=	0.0285

(Std. Err. adjusted for 4 clusters in q00)

		Coef.	Robust Std. Err.	z	P> z	[95% Conf. Interval]	
acadachvt							
years juku		.9392696	.4771544	1.97	0.049	.0040643	1.874475
/cut1		-.5067169	.8429937			-2.158954	1.14552
/cut2		1.54194	.4376586			.6841453	2.399736

Note: In Table 5, an ordered logistic regression of juku attendance and mathematics achievement is shown with mathematics achievement as the outcome variable and number of years attended *juku* as the predictor variable. Mathematics achievement is based on the elementary school mathematics grades of the student measured in the quantitative survey. The number of years attended *juku* proves a statistically significant predictor of mathematics achievement at the 0.05 α -level ($p = 0.049$). A one unit change in the number of years attended *juku* is associated with a 0.94 increase in the logistical odds of being in a higher category of mathematics achievement. Thus, a one unit change in number of years attended *juku* results in a significant difference on the outcome of mathematics achievement.

Table 6

Predicted probabilities of mathematics achievement based on number of years attended juku

Number of years attended <i>juku</i>	Predicted Probability of Outcome 1	Predicted Probability of Outcome 2	Predicted Probability of Outcome 3
0-1	0.1906	0.4556	0.3537
3-5	0.0843	0.3323	0.5834
6-7	0.0347	0.1835	0.7817

Note: Ordered logistic regression may be expressed as a probability as shown in Table 6, which provides predicted probabilities of mathematics achievement given the number of years of *juku* attendance. The predicted probability of a student with 0-1 years of *juku* having a low level of mathematics achievement is 0.1906, while a student with 6-7 years of *juku* having a low level of mathematics achievement is much less at 0.0347. On the opposite end of the spectrum, the predicted probability of a student with 0-1 years of *juku* having a high level of mathematics achievement is 0.3537, while a student with 6-7 years of *juku* having a high level of mathematics achievement is more than double that amount at 0.7817. Overall tests of the parallel regression/proportional odds and other assumptions were met.